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Numerical Solution of Micropolar Fluid Flow with Zero Mass Flux of Nanoparticles at Stretching Surface with a Porous Medium

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Abstract. This paper investigates the comprehensive investigation of mixed convection flow and heat transfers analysis of Micropolar by considering porous medium and heat absorption. Subsequently, mathematical formulation was modeled using boundary conditions. Two major aspects, Brownian motion and thermophoresis are addressed in the energy and concentration equation which are coupled with momentum equation. By using similarity variables, the entire system of partial differential equations govern through momentum, energy, angular momentum and concentration are converted into system of nonlinear ordinary differential equations. Nonlinear systems are solved by using numerical approach with bvp4c function in MATLAB that is based on the collocation method, specifically the three-point Lobatto IIIa formula is directed to type of finite difference method. Results are obtained for various emerging parameters. It has been observed that skin friction decreases for increasing values of Hartmann number and Eckert number. Decreasing trend of bar graphs is observed against Nusselt number and Sherwood number against Brownian motion and thermophoresis parameters.

AMS subject classifications: 65L06, 34C20

Key words: Zero mass flux, Heat transfer, Nanofluid, Boundary layer flow, Mixed convection, Numerical solution.

1 Introduction

Research in exceptional areas has been offered by fluid mechanics. The continuing advancement of fluid mechanics theory and applications has been facilitated by

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researchers. The most deep-rooted model of Navier-Stokes for classical fluids presents that the motions of Newtonian fluids seem to be incompressible. Nevertheless, Navier-Stokes representation is insufficient to explain liquids like polar fluids, fluids with microstructural components. These fluids are fascinating on their own and essential from a practical one. Most of these consisting of the Polymeric suspensions, blood of animals, crystals of liquid characterize these fluids that are complex. Their constituent particles could enlarge and contract, their shapes might vary, and they can rotate independently.

Several explanations have been proposed, even though basic deformable directed fluids, simple microfluid theories, and dipolar fluids all resemble the type of fluids containing microstructure. Eringen [1, 2] was the first to put out the theory of micro fluids, which thoroughly investigates the Navier-Stokes model. The microscopic movement and local structure for the fundamental elements of fluid are associated with microscopic effects that have been seen in micro fluids. Spin inertia has an impact on such fluids, which can withstand tension and bodily movements. Eringen [3] then advanced the notion of micropolar fluids. This theory contains established fluid medium that is under stress along with micro rotational effects, micro rotational inertia, and a couple stresses. He examined flow problems of one-dimensional micropolar fluids. He worked on one-dimensional micropolar fluid flow problems. Furthermore particular, he examined the uniform flow of micropolar fluids in different channels like ducts, tubes, circular, and spherical. Specifically, and presented graphical representations for coupled stress, shear stress differences, velocity, and micro-rotation profiles.

Physically, this category of bar-like elements in the same approach as the fluids that are isotropic fluids, e.g., crystals of liquids, that together with molecules resembling dumbbells, blood of animals, fluids containing polymers and those fluids which have additives. This theory has been predicted to also offer a mathematical explanation for non-Newtonian behavior seen in some synthetic liquids, such blood and polymers. Fundamental flow problems have been studied using Micropolar Fluid concepts framework. The research conducted in the field of micropolar fluid flow problems as well as its possible applications was first described by Ariman et al. [4, 5]. Turk et al. [6, 7], Hogen et al. [8], and Lee et al. [9] have tackled the blood flow models. In contrast, Allen et al. [11] proposed the idea of a lubrication of micropolar fluids. Tozeren et al. [10] used the concept of micropolar fluids for suspension.

Making use of a finite difference method, Chapman and Bauer [12] were successful in finding a group of accurate solutions to the Navier-Stokes equations. For micropolar instance, this issue was investigated Agarwal [13], Takhar, and Soundalgekar [13,14] discussed the flow and heat transport of both micropolar fluids over a porous medium. Mathur and Ena [15] investigated laminar convective boundary layer flow for a thermo-micropolar fluid using a non-isothermal vertical flat plate. A class of accurate solutions for the Magneto hydrodynamics flow for micropolar fluids trapped between parallel, non-coaxial, insulated, and infinite spinning discs were studied by Kasiviswanathan and Gandhi [16]. Lange [17], Guram and Smith [18] researched an accurate solution for the uniform Magneto hydrodynamics flow for a micropolar fluid examined, together with the stationary flow for micropolar fluids with powerful and fragile contact.